REMARKS

The specification has been amended to correct an editorial error. It can be seen that the original sentence was clearly in error since Mg-S precipitation cannot be both allowed and impeded in order to improve hole expandability. Support for the amendment is found at page 14, in the paragraph beginning at line 1 which describes that, when uncontrolled, Mn-sulfides precipitate at high temperatures, inhibit the production of Mg-sulfides and prevent sufficient improvement of hole expandability. It is clear that to overcome this problem, Equations 1-3 would have to provide for the precipitation of Mg-sulfides and the inhibition of Mn-sulfides in order to improve hole expandability. Therefore, the amendment does not introduce new matter.

Claims 1, 9-11 and 16-18 were pending in the application. In the Office Action mailed October 13, 2009, claims 1, 9-11 and 16-18 are rejected. In the instant Amendment, claims 16 and 17 have been cancelled without prejudice, and claims 1, 9 and 18 have been amended. Upon entry of the instant Amendment, claims 1, 9-11 and 18 will be pending in the application.

Claim 1 has been amended to recite the "consisting essentially of" transition phrase. Claim 1 has been further amended to recite Al not less than 0.08%. Support for this amendment can be found in the specification at page 27, Table 1, Steel X. Claim 1 has also been amended to incorporate the contents of claim 16, presently cancelled. Claim 1 has been amended to recite allowing precipitation of Mg-sulfides while impeding the precipitation of Mn- sulfides. Support for this amendment is found in the specification at page 3, lines 15-22.

Claim 9 has been amended to recite the "consisting essentially of" transition phrase. Claim 9 has been further amended to recite Al not less than 0.08%. Support for this amendment can be found in the specification at page 41, Table 11, Steel X. Claim 9 has also been amended to incorporate the contents of claim 17, presently cancelled. Claim 9 has been amended to recite allowing precipitation of Mg-sulfides while impeding the precipitation of Mn- sulfides. Support for this amendment is found in the specification at page 3, lines 15-22.

Claim 18 has been amended to recite a hole-expandability λ (%) of at least $-0.14 \times TS$ $(N/mm^2) + 2.3 \times 10^2$. Support for the amendment is found in the specification at p. 39, l. 33 through p. 40, l. 5, Tables 13-14, and Fig. 8. The equation represents a least square fit of the experimental data presented in Tables 13-14 (inventive steels E, F, J, N, R, S, X having Al

from 0.08% to 1.5 %) and Fig. 8 for inventive steels having the presently recited steel composition (see, Appendix A). Therefore, claim 18 encompasses steel sheet having a hole-expandability λ on or above the least square line fit.

No new matter has been added by these amendments. Entry of the foregoing amendment and consideration of the following remarks are respectfully requested.

Rejection Under 35 U.S.C. § 103

Claims 1 and 16 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Tsutomu JP2001-342543 (JP'543) in view of Yasuhara et al. US 6,364,968 (US'968).

Claims 1 and 16 are directed to steel sheets having a structure of primarily bainite in order to secure steel sheets having a tensile strength of at least $980N/mm^2$. The present inventors has discovered that hole-expandability is remarkably improved by the formation of Mg-sulfides, which conventionally has not been recognized. Equations (1) to (3) are designed to allow the precipitation of Mg-sulfides while impeding the precipitation of Mn-sulfides resulting in are combined precipitation, of MgO, MgS and (Nb,Ti)N. Mg precipitates have the effect of improving ductility and end-face properties. See the specification at p. 16, ll. 22-36.

The amount of Mg relative to the amount of O must be controlled to enable the formation of a sufficient amount of Mg sulfides in order to achieve the improvement of hole expandability while retaining sufficient tensile strength. The inventors have discovered that the amount of Mg addition to form a large enough quantity of Mg-sulfides, in order to realize the improvement of hole-expandability, should be greater than 80% of the assayed amount. Therefore, the amount of Mg addition must satisfy equation (1): $[Mg\%]\geq([O\%]/16\times0.8)\times24$.

Sulfur is essential in forming Mg-sulfides but also forms Mn-sulfides when present in large quantities, which deteriorate hole expandability. Therefore, the quantity of S must satisfy equation (2); $[S\%]\leq([Mg\%]/24-[O\%]/16\times0.8+0.00012)\times32$,with respect to Mg and O. Equation (2) defines the upper limit of the S content so as to inhibit MnS precipitation.

Oxygen is one of the most important additive elements used in the present invention and contributes to the enhancement of hole expandability by forming oxides by combining

with Mg. It is necessary to control the oxygen concentration for precipitating Mg-sulfides and thereby suppressing the formation of Mn-sulfides. However, the upper limit of the O content is set at 0.005% because excessive addition deteriorates the degree of steel cleanliness and thereby causes the deterioration of ductility. For controlling the O content, it is necessary to add Al as a strong deoxidization element. The specification describes that although 0.01% to 0.07% of Al is conventionally added, the present inventors discovered that large amount of Al addition improves ductility without deteriorating chemical convertibility. Al in the claimed amount from 0.08% to 1.5% is particularly necessary for providing compatibility between ductility and chemical convertibility.

The proportion of S to Mn is constrained according to equation (3); $[S\%]<0.0075/[Mn\%]$, derived from solubility product of Mn and S, to ensure a condition which inhibits Mn-sulfides precipitation. Excess S permits Mn-sulfides to precipitates and hole-expandability deteriorates.

Furthermore, the present inventors have discovered that limiting the contents of C, Mn, Ti, and Nb in steels primarily containing bainite is effective for securing ductility while maintaining strength and good hole-expandability by improving the end-face properties of punched holes by Mg-precipitates. See, specification at page 16, lines 31-36. The proportion of C and Ti controlled by equation (5) ensures hole expandability and the proportion of C to Mn is controlled by equation (6) balances strength and ductility. In order to secure strength in excess of 980 N/mm^2 it is necessary to control the proportion of C, Mn, Ti and Nb in accordance with equation (7). As previously discussed, these equations are not general formulae, but constraints on amounts of respective added elements which characterize steels having excellent tensile strength, hole expandability and ductility.

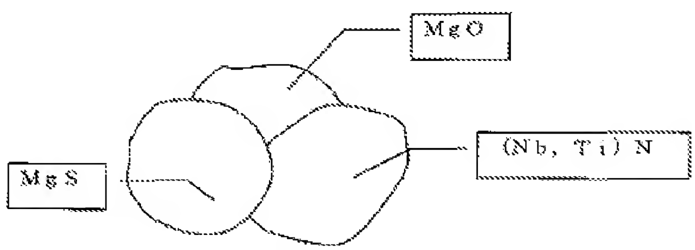
In contrast, JP'543 teaches steel sheets having a structure of primarily ferrite. See, translation of JP'543, p. 36, first paragraph, and pp. 43-45, ¶¶ [0006]-[0010]. JP'543 does not teach or suggest steel sheets having a structure of primarily bainite, nor sufficient tensile strength. JP'543 does not teach or suggest controlling the oxygen level to not more than 0.005 %, to controlling Mg depending on the amount of O (Eq. 1), or controlling the amounts of C, Mn, Ti, and Nb in accordance with equations (5)-(7).

JP'543 does not teach or suggest the claimed composite precipitates of MgO, MgS and (Nb, Ti)N. Instead, JP'543 teaches MgO inclusions or combined precipitates, such as

Al_2O_3, SiO_2, MnO and Ti_2O_3, or combined precipitates surrounded by (Nb, Ti)N, as shown in the following Fig. 1, which are quite different from those of the present invention. More precisely, JP'543 describes that MgO is preferable with one or more complex oxides such as Al_2O_3, SiO_2, MnO and Ti_2O_3. See, paragraph [0027]. Further, Mg and $MgAl_2O_4$ mainly have an effect of form of fine void by means of neighboring precipitation of (Nb, Ti)N neighboring those complex oxides, and it is considered MgO and $MgAl_2O_4$ contribute as nuclei for uniform distributed precipitation. See, paragraph [0028]. Fig. 1 shows a comparison of the present inventive combined precipitates and the inclusion described in JP'543.

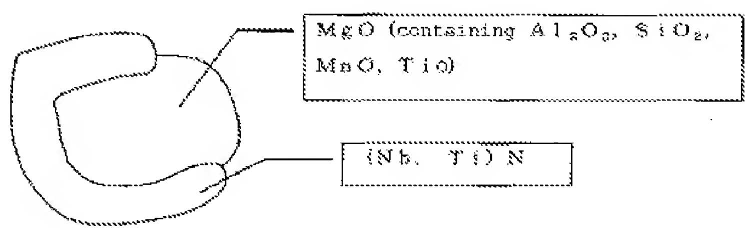
Fig. 1

Present inventive combined precipiates



Inclusion disclosed in D1

Inclusion disclosed in JP'543



Furthermore, JP'543 does not teach or suggest Al in the amount from 0.08% to 1.5%. In contrast, JP'543 teaches conventional Al addition and that an Al in excess of 0.07% should be avoided since it would prevent the formation of essential Mg-Al complex oxides of the JP'543 technology. See, JP'543 at paragraph [0024].

The Examiner acknowledged that JP'543 does not teach the bainite structure and the tensile strength required by claim 1. However, the Examiner suggested that US'968 teaches a steel having a composition similar to that of JP'543 and bainite structure as well as high tensile strength and hole expandability, a person of ordinary skill in the art would apply the

heat treatment process of US'968 to the steel of JP'543 and arrive at the presently claimed invention.

However, in contrast to the Examiner's contention, the steels of JP'543 and US'968 are not similar and rely on distinct elements in the composition in order to arrive at the desired properties of their respective steels. For example, the JP'543 steel requires Mg from 0.0005 to 0.01% in order to precipitate Mg oxides and thereby achieve the mostly ferrite structure with excellent hole expansibility. See, JP'543, p. 42, ¶ [0005]. In contrast, the US'968 steel does not include Mg and instead requires B in order to suppress ferrite transformation in the steel resulting in a bainite microstructure. See, US'968 at col. 7, ll. 50-53. Thus, a person of ordinary skill in the art would expect that the difference in microstructure would be due to the difference in steel composition and not the heat treatment process. A person of ordinary skill in the art would not expect to combine the steel composition of JP'543 and the heat treatment of US'968 and expect to arrive at the present invention.

Applicants further note that the objective of JP'543 is to secure a mainly ferrite microstructure and teaches a steel composition and processing steps in order to achieve the disclosed tensile strength, hole expansibility and ductility. For example, JP'543 explicitly teaches an air cooling temperature of less than 700°C. JP'543 for the purpose of securing the mostly ferrite microstructure. See, JP'543, at p. 54, ¶ [0035]. Thus, a person of ordinary skill in the art would not seek to modify the JP'543 heat treatment process that provides the very microstructure that endows the steel sheets with the inventive property of excellent hole expandability.

US'968 does not remedy the deficiencies of JP'543. Thus, claims 1 and 16 are patentable over JP'543 and US'968, either individually, or in combination.

Claims 9-11, 17 and 18 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Tsutomu JP2001-342543 (JP'543).

Claims 9-11, 17 and 18 are directed to steel sheets having a ferrite + bainite structure which achieves superior strength, expandability and ductility by, *inter alia*, controlling the amounts of added elements according to Equations (1)-(4). The present inventors discovered that hole-expandability is remarkably improved by the formation of Mg-sulfides, which conventionally has not been recognized. Equations (1) to (3) are designed to allow the

precipitation of Mg-sulfides while impeding the precipitation of Mn-sulfides resulting in are combined precipitation, of MgO, MgS and (Nb,Ti)N. These Mg precipitates have the effect of improving ductility and end-face properties. See the specification at p. 16, ll. 22-36.

Also, in order to secure the adequate amount of ferrite effective for the enhancement of ductility, C, Si, Mn and Al contents must satisfy equation (8): $-100 \leq -300[C\%]+105[Si\%]-95[Mn\%]+233[Al\%]$. If the value of equation (8) is smaller than -100, ductility deteriorates because an adequate amount of ferrite is not obtained and the percentage of the second phase increases. See, specification at the paragraph bridging pages 22 and 23.

As discussed above, JP'543 does not teach or suggest the additional constraints on the amounts of the added elements as defined by the recited equations. JP'543 does not teach or suggest controlling the oxygen level to not more than 0.005 %, controlling Mg depending on the amount of O (Eq. 1), or controlling the amounts of C, Si, Mn and Al in accordance with equations (8). JP'543 does not teach or suggest the claimed composite precipitates of MgO, MgS and (Nb, Ti)N. JP'543 does not teach or suggest Al in the amount from 0.08% to 1.5%.

As previously presented, Appendix A presents a chart showing hole-expandability λ as a function of tensile strength TS for the inventive steels of Example 3 (Inventive Steels E, F, J, N, R, S and X having Al from 0.08-1.5%) of the present application as well as steels of JP'543 (Tables 2 and 4). The chart shows that, in general, hole expandability decreases as tensile strength increases. However, a meaningful evaluation of hole expandability must be made with a comparison at the same tensile strength. Applicants note that when comparing hole expandability for the claimed and JP'543 steels having the same tensile strength, hole expandability of the claimed steel sheets are much higher for all tensile strengths in the tested range. In fact, not a single data point of JP'543 reaches the line fit of hole expandability as a function of tensile strength of the present invention. Thus, the steel sheets of JP'543 are clearly inferior in hole-expandability than the presently claimed steel sheets over the claimed range of tensile strength.

In the office action, the Examiner contends that the presently claimed steel sheets can be achieved by routine optimization of the amounts of the added elements. Applicants respectfully submit that "[a] particular parameter must first be recognized as a result-effective variable, *i.e.*, a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine

experimentation." MPEP at p. 2100-152 (rev. 6, Sept. 2007). In the present case, each of the recited equations defines a relation of the amounts of two or more added elements, which must be satisfied to achieve the tensile strength, high hole expandability and ductility. For example, equation (1) $[Mg\%] \geq ([O\%]/16 \times 0.8) \times 24$ requires that the amount of Mg be no less than a quantity determined based on the amount of O. In order to find such an equation, a person skilled in the art would have to first discover a correlation between the amounts of Mg and O affects hole expandability and ductility, and then experiment to find the relation between the amounts of Mg and O and to obtain the equation. None of the cited references recognizes, e.g., that a correlation between the amounts of Mg and O affects hole expandability and ductility. None of the cited references teaches or suggests controlling the amount of O in its steels. Therefore, the relation as defined in equation (1) is not recognized as a result-effective variable. The same applies to each of the rest recited equations. A person skilled in the art would not have arrived at these equations by routine optimization.

Thus, claims 9-11, 17 and 18 are patentable over JP'543.

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

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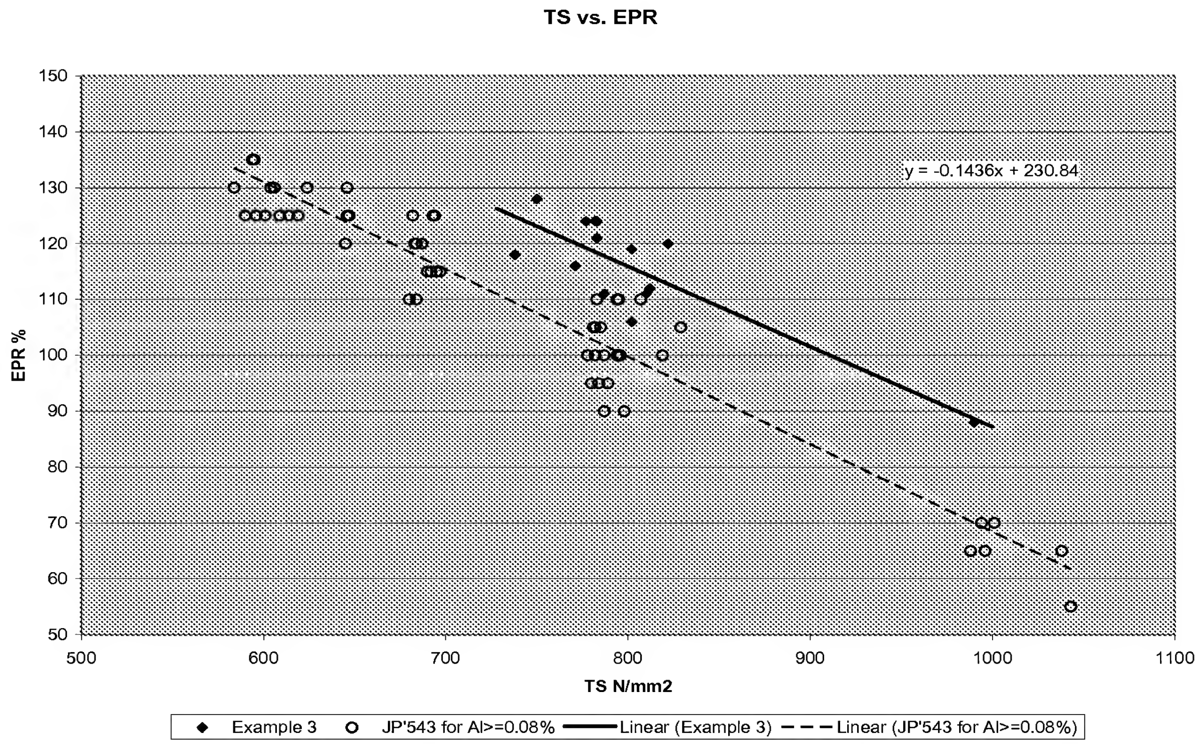
APPENDIX A



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